

Construction Report  
Experimental Features Project  
MEMBRANE PROTECTION FOR STEEL STRINGER TOPS

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Yaquina Bay Bridge  
Newport, Oregon

by

Charles W. Elroy  
Resident Engineer

and

Gordon Beecroft  
Research Engineer

Oregon Department of Transportation  
Highway Division

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# C O N S T R U C T I O N   R E P O R T

## Experimental Features Project

### MEMBRANE PROTECTION FOR STEEL STRINGER TOPS

#### Yaquina Bay Bridge

#### History

The Yaquina Bay Bridge on the Oregon Coast Highway at Newport, Oregon has direct coastal exposure to the Pacific Ocean, which has resulted in serious corrosion problems related to structural and reinforcing steel in the structure. This problem is particularly concentrated in steel members under the deck where salt-laden moisture condenses and is not washed away by the rain. Corrosion of the steel reinforcing bars in the bottom of the concrete deck had caused spalling of the concrete to the extent that the entire deck and sidewalk throughout the three steel arch spans had to be completely replaced. The deck replacement utilized steel grid decking over the existing steel stringers.

#### Experimental Feature

The experimental feature of this project was to evaluate the application and performance of Chevron Industrial Membrane applied to the tops of steel deck stringers and other similar members as corrosion protection in conjunction with the deck replacement project on this structure.

#### Purpose

The tops of the existing deck stringers, sidewalk support channels, and other similar members on the bridge were previously covered by concrete of the deck and sidewalk. Removal of the old concrete deck and sidewalk provided an opportunity to clean and recoat the tops of these members prior to covering them again by the new concrete filled steel grid replacement deck. Coating

of these members with the Chevron Industrial Membrane material is expected to provide superior protection from corrosion over a longer period of time than if coated with conventional painting materials.

### Construction Details

The Chevron Industrial Membrane was used to protect steel members that would not be accessible for sandblasting and painting after the new deck was in place. This included the tops and edges of deck stringers, diaphragm beams and sidewalk supports. The product is intended as a "permanent" solution to corrosion in those areas. Work involving the membrane application began December 12, 1979 and was completed April 21, 1980.

All surfaces to be coated were prepared with a "commercial sandblast" conforming to the Pictorial Standard SA2 of ASTM 2200 or cleaner. Much of the blast was "near white". After sandblasting, the surfaces were wiped with Chevron Bonding Agent.

Temperatures at the time of application ranged from 40°F to 70°F. During inclement weather the membrane was applied under a plywood shed. Space heaters were used to warm the shed during weather having temperatures of 45°F or colder. The shed remained over the fresh membrane until it "skinned over" or became tack-free to prevent rain damage, normally an hour or two.

The membrane material is a two component, extended urethane consisting of Chevron Premix CIM and Chevron Activator CIM. Under the working conditions on this project, it was found there was very little latitude for error in the handling and mixing of the material. There was a wide range of results in the final curing of the membrane. The material varied from not curing or setting up at all to curing hard and brittle. For the most part, however, the Chevron Industrial Membrane (CIM) cured to a solid but remained flexible and rubber-like. Material that did not cure properly was later

removed and replaced. The time required for the membrane to cure adequately to permit deck placement was a critical factor in the work schedule on the project. Curing time of the membrane to permit placement of the grid decking varied according to the temperature and ratio of activator and premix. Initial curing generally took four to five hours when the ambient temperatures were in the 60's or when the air under the plywood shelter was raised to this range. Initial curing took eight to twelve hours when the temperatures were in the 40's. If excess activator was used to reduce the curing time, the mixture would sometimes set up too quickly and not allow time for application. The manufacturer's literature indicates the material will cure within 24 hours to form a tough, resilient membrane. However, it was found complete curing of the membrane took from a matter of hours to several months, depending on temperatures and mix proportions.

The manufacturer's recommended thickness of application was 0.050 inches. Thickness readings were taken frequently throughout the job. The wet membrane was checked with a wire having a diameter of 0.050 inch. The dry membrane was checked with a Nordson dry film thickness gage. The CIM was difficult to place to a precisely uniform thickness but in this application, some variation in thickness would be of no consequence.

Trowel and spray grades of Chevron Industrial Membrane were used on this project. Both grades were applied with steel concrete trowels. The trowel grade was used exclusively on the east half of the deck and interchangeably with the spray grade on the west half. We can find little to recommend the use of the trowel grade on a project of this nature for several reasons:

- (1) Material is very sticky and messy to handle.
- (2) It is very difficult to apply uniformly; impossible around rivet clusters. The material would not flow. There were always thin spots to be patched and thick spots to be trimmed. It would sag and drip from vertical edges.

- (3) The quick set-up time (10 minutes±) allowed little time for application and limited mix batches to one gallon.
- (4) Because of these problems, there was excessive waste. The calculated job quantity was approximately 300 gallons. Over 800 gallons were used.

An advantage of the trowel grade on this project was that it did cure more quickly to allow the setting of the grid decking in four to five hours normally as opposed to a usual time of five or six hours for the spray grade.

The spray grade was easier to apply. It had the consistency of a thick paint and would flow into a uniform coating. A disadvantage of the spray grade was the tendency to run down to surfaces that were not to be coated and to "string" down from the edges of the deck stringers. However, these strings were easily trimmed after the membrane had cured.

Most of the problems encountered during application of the Chevron Industrial Membrane on this project can be attributed to the lack of trained and experienced personnel. For instance:

- (1) The activator was allowed to cool to the point of crystallization during storage (60°F) which reduced its effectiveness.
- (2) The protective warming shed was moved too soon on occasion, resulting in some rain damage to the membrane.
- (3) Carelessness, inaccurate proportioning and inadequate mixing time were probably the reasons for most of the curing and end result variations.
- (4) During the early stages of the project, lacquer thinner and diesel oil were used for tool clean-up. The diesel oil use was discontinued when it was suspected to be a source of contamination, causing a delay in the membrane curing.
- (5) Small sags from the edges of the deck stringers were initially left untrimmed. These later interfered with the painter's sandblasting and had to be cut back to the edge of the flange.

Adequate training for those applying the material and for those inspecting its application should be a requisite for the use of the Chevron Industrial Membrane. The manufacturer's instructions must be strictly adhered to.

### Labor and Cost Breakdown

The Chevron Industrial Membrane crew generally consisted of one foreman half time and four laborers full time. The usual activity for the laborers would have one sandblasting, one mixing the CIM, and two applying the membrane material.

#### Labor:

Foreman	-	250 man-hours @ \$20.40/hr	= \$ 5,100
Laborers	-	2,000 man-hours @ \$19.90/hr	= \$39,800

#### Material:

Chevron Industrial Membrane	-	840 gallons (invoice total)	= \$12,494
Sandblasting Sand	-	30 tons @ \$80.00/ton	= <u>\$ 2,400</u>

TOTAL = \$59,794

Cost per Square Foot =  $\frac{\$59,794}{8,211 \text{ sq ft}}$  = \$7.28/sq ft

### Initial Appraisal

A report dated August 22, 1980 stated the membrane appeared to be performing well at that time. Adhesion to the steel is generally good, although there are occasional areas on the edges of the deck stringers where the membrane can be pulled free. This may be due to the mix being applied after it began to set or it may be caused by surface contamination of moisture or dust. There is no visible pinholing of the membrane. Once the CIM had cured, there was no indication that placement of the grid deck and concrete caused any extrusion of the membrane.

It is intended that annual inspections will be made over a 3-year period to provide a further evaluation of the product for this type of application.

### Photographs

Included with this report are eight photographs which provide a visual portrayal of the placement and performance of the CIM. The captions

accompanying the photographs need no further discussion. The report describes some difficulty in placing the material to a uniform thickness and this is especially true in areas with difficult access. The pictures also illustrate the extrusion of membrane material for mixtures that were slow to cure. The cause is believed to be the result of poor mixing or improper proportioning of the premix and activator under the prevailing climatic conditions.

1-24-80

Squeezing out of Chevron  
Industrial Membrane in  
Span 2, due to improper  
mixture. Material did  
harden later.



1-24-80

Looking at Chevron  
Industrial Membrane  
in Span 3 squeezing  
out after grid was  
laid and traffic  
allowed over top.  
Material did harden  
some time later,  
softness due to  
improper mixture.

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1-24-80

Looking at application of  
Chevron Industrial Membrane  
in Span 1.



1-24-80

Looking at application  
of Chevron Industrial  
Membrane in Span 1.  
Note irregular surface  
of membrane.

2-6-80

Application of Chevron  
Industrial Membrane on  
stringer beams at Pier 1.



2-6-80

Coating beams at Pier 1  
after they were sandblasted.



1-24-80

Looking at placement  
of grid panels.

1-24-80

Chevron Industrial Membrane  
still soft and tacky after  
grid decking placement,  
probably due to improper  
mixture. Material did  
harden later.

